

Every linguist analysed a tree.

Seminar week 1: Is there any time for scope? Winter 2014/2015

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# Which maid has which mop?

*The Walrus and the Carpenter  
Were walking close at hand;  
They wept like anything to see  
Such quantities of sand:  
“If this were only cleared away,”  
They said, “it would be grand!”*

*“If seven maids with seven mops  
Swept it for half a year.  
Do you suppose,” the Walrus said,  
“That they could get it clear?”  
“I doubt it,” said the Carpenter,  
And shed a bitter tear.*

— Lewis Carroll, *The Walrus and the Carpenter*.

# Is there any time for scope?



*Cool Peppermint*



*Cinnamon Ice*



*Original Mint*



*Citrus Splash*

**Surely the answer is: yes**

**Surely the answer is: yes, there is  
any time for scope.**

(Because it's true, of course.)



# But English-speakers reject the use of “any” that way.

Acceptable:

- Is there any time for scope?
- No, there isn't any time for scope. [direct negation works]
- No, there's no time for scope. [equivalent to above]
- I wouldn't say that there is any time for scope.
- When did Bob say that there is any time for scope?

# But English-speakers reject the use of “any” that way.

Never:

- \*Yes, there is any time for scope.
- \*I can say that there is any time for scope.
- \*Bob said that there is any time for scope tomorrow.



# What is so special about “any”?

It's a “negative-polarity item”.

- That means it must usually\* exist in a “downward-entailing” environment.
- Upward-entailment: implies a larger set of events, preserves semantic “strength”.
  - John ran fast  $\Rightarrow$  John ran.
  - (But not the other way.)
- Downward-entailment: reverses semantic “strength”.
  - Nobody ran  $\Rightarrow$  Nobody ran fast.
  - (But not the other way.)

\*There's something called “non-monotone” but let's leave this out.

# What is so special about “any”?

Downward entailment:

**No, there isn't any time for scope.**

⇒

**No, there isn't any time for thinking about scope.**

⇒

**No, there isn't any time for thinking about quantifier scope.**

But it doesn't imply that there isn't any time for thing about anything!

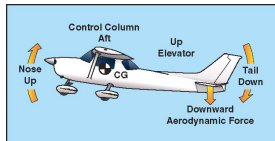


Figure 4-6. The elevator is the primary control for changing the pitch attitude of an airplane.

# This is a question of meaning relations. . .

. . . but it has a relation to the structure of the sentence.

Is there		<b>any time for scope</b>
I wouldn't say that there is		
When did Bob say that there is		

# It's like there is something that “validates” the any-phrase.

Let's postulate an operator  $\phi_{DE}$  (for Downward Entailment).

Is there	$\phi_{DE}$ ( <b>any time for scope</b> )
I wouldn't say that there is	
When did Bob say that there is	



# This gives us a crude first definition of “scope”.

$$\phi_{DE}(\text{any time for scope})$$

A scope consists of

- an **operator** that maps from structure  $\Rightarrow$  interpretation.
- a **structure** to which the operator is applied.

(What specifically that operator really is, we'll take a pass on for now.)

**But that leaves us with an obvious couple of questions.**

What the heck is a **structure**?

What the heck is an **operator**?

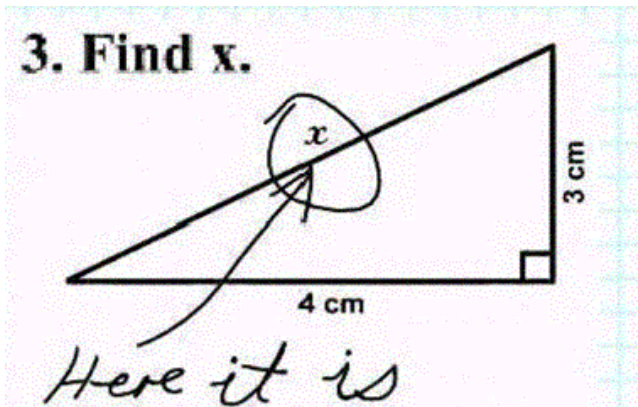


**Actually, it leaves us with one more question.**

**What does it mean to apply and interpret?** (Well, two more questions.)

**WARNING WARNING:** We now begin **OVERSIMPLIFICATION**. (I wish

Latex had blink tags.)



# How can we think about structure?

**Structure** mediates between “articulatory” and semantic form.

- And what is omitted or not articulated is as important as what is.
- One task of the linguist: find a way to infer what is *not* articulated that has an effect on structure and interpretation.
- But also: find a way to infer what is not interpreted that has an effect on structure and articulation. . .
- Typical example: syntactic trees.

# How can we think about operators?

**Operators** are bridges between semantic forms and interpretations and between different interpretations.

- Usually expressed as some kind of higher-order logical function.
- Usually “bind” variables within the scope, limiting their interpretation.
- Usually applied to semantic expressions (but have a presence in some theories of syntax).
- Typical examples:  $\exists, \forall \dots$ , but many “exotic” kinds.

# How can we think about interpretation?

So many different approaches:

- Model-theoretic: mapping elements of expression to “individuals” and truth values.
- Proof-theoretic: role of an expression in a system of inferences.
- Truth-conditional: like model-theoretic, but without mapping to individuals in a domain.
- Probabilistic.
- ...

(But we're not going to focus on this can of worms. Let us just assume “model-theoretic” interpretation for now.)

# How can we think about applying an operator?

Ah, now we're really getting into the "weeds"!

- Conventionally: applying a "higher-order function" to a semantic expression.
  - To convert it into another expression with a different type.
- But we are not conventional:
  - Psycholinguistic consequences: does operator application affect the human processor/learner?
  - Technological: how do operators and scope interactions affect machine understanding of NLPs?

# But that's a lot of things to mix together!

It affects/is affected by linguistic representation at all levels:

- Syntactic: not every operator is allowed everywhere, like “any”, even if they “make sense.”
- Semantic: not every operator “makes sense” everywhere – or they're ambiguous.
- Pragmatic: world-knowledge affects how you choose to interpret – “Every child climbed a tree”.

Even things like prosody are important: “every child climbed **A** tree.”



# Goals of the seminar

- To gain a broad understanding of different types of scope phenomena.
- To understand how scope phenomena affect different levels of linguistic representation.
- To get an overview of different approaches to investigating scope phenomena: theoretical, formal/logical, psycholinguistic, and computational.
- To give students further practice in debating, critiquing, and creating linguistic thoughts.

**Ideally: a discussion group atmosphere.**

# Who should take this seminar?

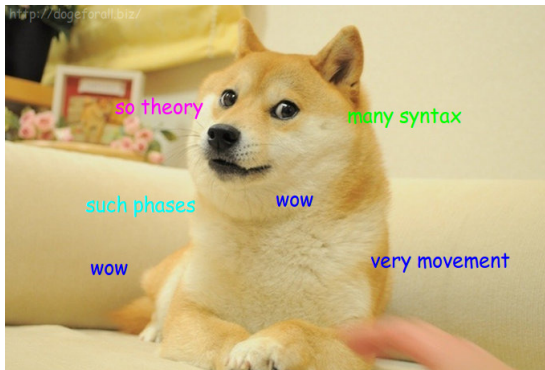
I want to avoid this seminar being too specialized.

- Scope can be dealt with a very technical way, want to minimize the requirement to know a lot of formalism.
- Unfortunately, formalism is unavoidable, I'm hoping this is all we'll need:
  - Basic first-order predicate calculus.
  - Lambda-calculus would be nice.
  - Some notion of syntactic formalism, ideally "traditional" ( $S \rightarrow NP VP$ , etc).
- I'll try to give a little refresher.

**In this seminar, I want to focus on  
BREADTH, not DEPTH.**

# And the details...

- Meeting: Wednesday 10-12.
- First meeting: Today.
- Location: C7.2 2.11.
- And there may be the occasional doge.



# And yet more details. . .

- Please read the web page:  
<http://www.coli.uni-saarland.de/courses/scope14/>
- **Must** sign up for the mailing list (on the web page).
- The schedule will unfold “dynamically” – I will list readings on the mailing list as well as on the web site.
- I have listed some suggested papers for presentation on the web site with links, but the list is not exhaustive!

**“Getting to know you” pause.**

# Yes, we have requirements.

I'm not 100% sure how all of this stuff works, but I know:

- For any credit at all, all of you **HAVE** to do a presentation.
  - And I expect most of you to attend the presentations, most of the time.
- Some of you will want/need additional credit: write a term paper, requirements to be discussed based on how challenging your topic is.
- Yes, I do oral exams for those who need the credit for that.

# What can you present/write a term paper about?

Possible types of topics:

- A specific **paper** in the literature, including but not limited to what I put up on the web page.
- A survey of opinions on a particular **scope phenomenon** across languages.
- A survey of a particular (claimed) **principle**.
- Your own original idea.
- ...



# What do we mean by a “theoretical” paper/topic?

- A detailed attempt to describe a particular phenomenon.
  - If you want to do something outside of English, it's particularly welcome.
- An attempt to explain a family of phenomena based on underlying linguistic *principles*, ideally independent of specific formalism.

# What do we mean by a “formal/logical” paper/topic?

- Describing the underlying logic of scope relations, e.g. how downward entailment works with NPIs.
- Theories of ambiguity and underspecification.
- Formal systems for describing the logic of operators and scopes.
- Mappings between syntactic and semantic formalisms (e.g. TAGs to neo-Davidsonian semantics).

# What do we mean by a “psycholinguistic” paper/topic?

- Scope in acquisition and development, i.e., how children learn to assign operators to correct scopes.
- Studies of adult processing:
  - The time course of scope processing.
  - Semantic and pragmatic biases in scope interpretation.

# What do we mean by a “computational” paper/topic?

This one shouldn't be hard to guess :)

- Computational models of operator-scope structures in text.
- Online interpretation of scope: disambiguation, influence of grounded knowledge, etc.
- Scope in natural language generation.

Hardest to find, because as I said, this is really the edge.

# How should you present it?

Possible presentation style:

- Good old slideshow – safest, I suppose.
- Detailed handout (traditional for syntax papers in particular).
- Even a well-presented whiteboard discussion is OK.

You will also *lead discussion* of the idea/paper/etc.

# The (rough/tentative) schedule

- Week 1 (today): this intro stuff.
- Week 2-3: Basics of scopes and operators, particularly wrt quantifier scope.
- Remaining weeks: student presentations.

The last two Wednesdays before Christmas will have to be rescheduled.

# Some things to consider

We are only trying to skim the highest levels: breadth more than depth!

- I don't expect you to understand deeply everything you read for the course.
- Theory changes over time and the “intro material” can become outdated, other than the basic axioms of logic.
- I want you to instead learn to “appreciate” the material at an abstract level and be able to pursue the “useful” threads.

# USEFUL?!?!!





# Well, sort of. . .

My opinion: scope is one of the next frontiers.

- In terms of cognitive science: the abstraction required is extremely hard to capture neurolinguistically.
- In terms of technology: interpreting and responding to complex queries/interactions in context.

# CoLi is getting more grammatically detailed.

The underlying principles are starting to matter. An example from my own experience.

- The “corner cases” of quantifier interpretation (a syntactic AND semantic issue) have long been central in theory.
- **Just** becoming relevant in spoken dialogue systems.
- But how to handle it without e.g. **movement**? Not always easy.
  - There are a lot of movement-o-phobes :) so there's a lot of formal work on this!

**So having said all that, let's talk a little bit about formalism.**

# Say hello to some variables.

$x, y, z$

(Hi, variables!)

# And a unary predicate

child( $x$ )

This just says: “ $x$  is a child”.

# And a **binary** predicate

$\text{climb}(x, y)$

This just says: “ $x$  climbs  $y$ ”.

# Conjunction. . .

$$\text{child}(x) \wedge \text{tree}(y)$$

This just says: “ $x$  is a child and  $y$  is a tree”.

# ... and disjunction ...

$$\text{child}(x) \vee \text{tree}(x)$$

This just says: “ $x$  is a child or  $x$  is a tree”.



# ... and implication.

$$(\text{child}(x) \wedge \text{tree}(y)) \rightarrow \text{climb}(x, y)$$

This just says: “if  $x$  is a child and  $y$  is a tree,  $x$  climbs  $y$ ”.

**But we usually want variables to be  
“bound”. (Why?)**

# Existential quantification...

$\exists x \text{ child}(x)$

This just says: “there exists an entity  $x$  such that  $x$  is a child”.  
(Quantification scope established!)

# . . . and universal quantification.

$$\forall y \text{ tree}(y)$$

This just says: “for all entities  $y$ ,  $y$  is a tree” .  
(And we can have many more exotic quantifiers/operators.)

# *Et voilà!*

“Every child climbs a tree”:

$$\forall x \text{ child}(x) \rightarrow \exists y \text{ tree}(y) \wedge \text{climb}(x, y)$$

This just says: “for all  $x$ , if  $x$  is a child, then there is a  $y$  such that  $y$  is a tree, and  $x$  climbs  $y$ ”.

**Whew!**

# Except: the magical language gremlins are not always so nice.

“Every child climbs a tree”:

$$\exists y \text{ tree}(y) \wedge \forall x \text{ child}(x) \rightarrow \text{climb}(x, y)$$

This just says: “there is a  $y$  such that for all  $x$ ,  $x$  is a child, and  $x$  climbs  $y$ ”.

**And how the gremlins do this is our question for this course.**





# But since we made it this far...

... one more puzzle:

Two politicians spied on someone from every city.

How many interpretations does this have? Can we count them in terms of quantifier scope orders?

**I will put up next week's reading shortly, but it will be the first half of Ruys and Winter (link on web page).**